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(TOTAL 12 SHEETS WITH COVER)					
		MITSUI ENGINEERING & SHIPBUILDING CO.,LTD.			
SHIP & OCEAN PROJECT HQ.		PRODUCT NAME		TYPE	
		FineBallast MF			
BUSINESS DEVELOP. DEPT.		バラスト水管理システム 陸上試験計画書			
APPROVED					
CHECKED					
PREPARED					
DRAWN		LAND BASED TESTING PLAN DOCUMENT			
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## **Land-based Testing Plan**

### **1. Scope of Application**

This planning document concerns the land-based testing of the “FineBallast MF” ballast water management system (BWMS).

### **2. Purpose of the Test**

In the test described herein, the “FineBallast MF” BWMS is tested using a land-based full-scale test set to verify its compliance with Regulation D-2 of the International Convention for the Control and Management of Ships’ Ballast Water and Sediments, 2004.

The test is conducted according to provisions in “[6] Land-based Testing” of the Ballast Water Management System Pre-service Test Criteria.

### **3. Test Site**

Name: Korea Ocean Research & Development Institute (KORDI)

Address: 391 Jangmok-Ri Jangmok-Myon Geoje 656-830, Korea

### **4. Test Set Overview**

Fig. 1 represents the test set by a simplified flow diagram. See Attachment 1 for the test set layout.

The test set is configured as a BWMS set up on the deck of a barge. The barge has dummy ballast tanks in its hold for use during the test.



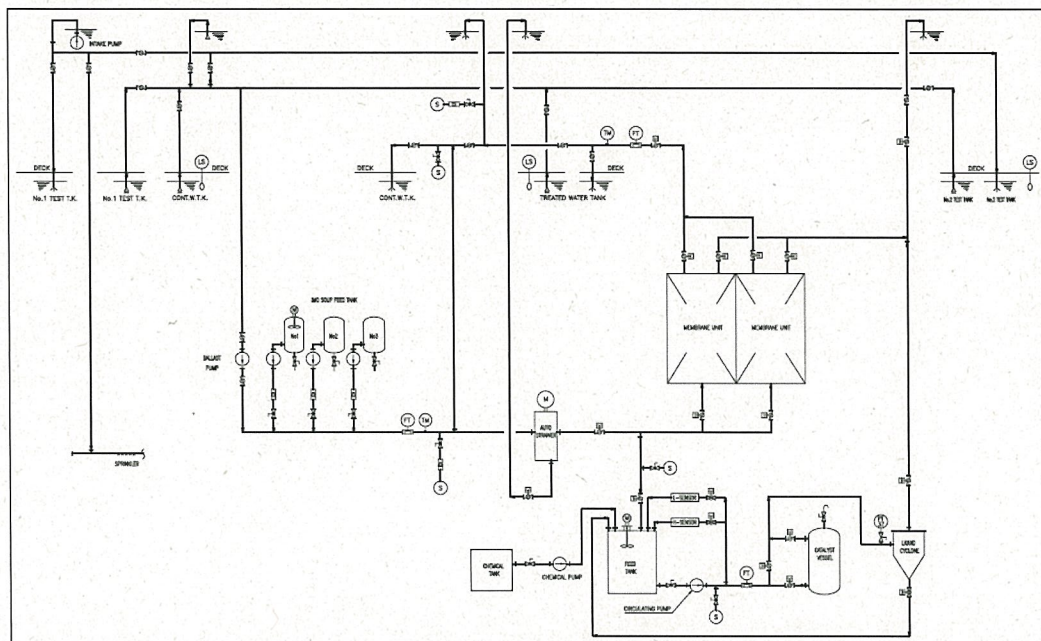


Fig. 1 Test set flow diagram



## 5. Test Schedule and the Number of Iterations

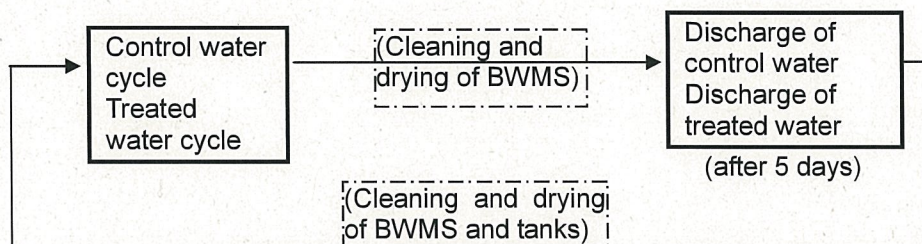
Treated water type	Schedule	Iterations
Seawater	May to October 2010	5 cycles
brackish water	July to September 2010	5 cycles

## 6. Test Set

- Test set type: FineBallast MF land-based test set  
\* For more information about the test set, see “D-02-00 Land-based Test Set.”
- Treatment capacity: 200m<sup>3</sup>/h

Table 1 lists the specifications of the major components of the test sets:

The test set is cleaned at the end of each test cycle and also during an interval between the ballast water operation and the ballast water discharge operation.



- Control water cycle: filling a tank with control water (untreated water serving as control sample)
- Treated water cycle: filling a tank with treated water



Table 1 Specifications of major components

No.	Component	Specifications, etc.
1	Membrane unit	Membrane module: 96 modules Membrane cassette: 16 cassettes
2	Clean-in-Place (CIP) system	Circulation tank: 1 unit Chemical solution tank: 1 unit Chemical solution injection pump: 1 unit Circulation water pump: 1 unit Catalyst vessel (for detoxifying operation): 1 unit Cyclone type strainer: 1 unit
3	Prefilter	Automatic back-wash type strainer: 1 unit Pore size: 100 $\mu$ m
4	Ballast water pump	Vertical centrifugal pump 250m <sup>3</sup> /h x 30mH
5	Control panel	Main control panel x 1 Relay panel x 1
6	Electromagnetic flowmeter	Incoming water flowmeter: 0 to 500m <sup>3</sup> /h, 1 unit Treated water flowmeter: 0 to 500m <sup>3</sup> /h, 1 unit Chemical solution flowmeter: 0 to 100m <sup>3</sup> /h, 1 unit
7	H <sub>2</sub> O <sub>2</sub> sensor	Ranges: 0 to 50mg/L (LOW) 0 to 20,000mg/L (HIGH)
8	Test tanks	Tanks installed to a steel barge: For incoming water: 300m <sup>3</sup> x 2 For control water: 200m <sup>3</sup> x 1 For treated water: 200m <sup>3</sup> x 1



## 6. Test Cases and the Preparation of Incoming Water

Two among the three ranges of salinity defined in Table 2, namely, “32PSU or more” (seawater) and “3 to 32 PSU” (brackish water) should be chosen as two test cases. As to the number of iterations, an experiment for each test case should be repeated five times (making up the total: 10 times). The salinity should differ between the two test cases by 10PSU at least. With both test cases, the water supplied to the test set should be sourced from the local sea. Water taken from the sea should first undergo the adjustment of salinity. For tests to be conducted at the salinity of seawater, no adjustment of salinity is required as long as the salinity of the seawater from the local sea, measured after it is taken into the incoming water tanks, is 32PSU or more. If the salinity turns out to be less than 32PSU, oceanic water or artificial seawater of higher salinity should be added until the salinity increases to 32PSU or more. For tests to be conducted at the salinity of brackish water, the salinity should be measured on the seawater taken from the local sea as in the case of tests to be conducted at the salinity of seawater. Then spring water or demineralized water should be added until the salinity drops below 22PSU.

The required water quality conditions should be produced using the under-mentioned product. The required quantity of this product is determined by calculation with sufficient assurance of being able to achieve the required water quality conditions from the pre-examined relationship between the quantity of this product added to water and the quantities of target substances produced in water. However, the quantity of this product may need to be readjusted depending on the original constitution of seawater.

- (1) Dissolved organic carbon (DOC) source: seaweed powder
- (2) Particulate organic carbon (POC) source: as above
- (3) Total suspended solids (TSS) source: as above

The required biological conditions should be met using the organisms listed below. These organisms should be added to water using a pump together with the above-mentioned product used for water quality adjustment.

- (1) Species of organisms to be added to water for adjusting the concentration of organisms that are 50µm or larger in size (L-size organisms): *Artemia salina*

The concentration of L-size organisms in the seawater around the test site is known to be normally at the level of  $10^5$  organisms/m<sup>3</sup>. If the analysis of the local seawater before the test demonstrates the possibility of the concentration being less than  $10^5$  organisms/m<sup>3</sup>, a required quantity of the cultured organisms of the above-mentioned



species should be added to the water.

(2) Species of organisms to be added to water for adjusting the concentration of organisms that are 10µm or larger but smaller than 50µm in size (S-size organisms):

*Tetraselmis sp.*

A sufficient quantity of phytoplanktons should be added to ensure that its concentration in the incoming water is approximately twice as large as the minimum requirement. Before each test, the concentration of S-size planktons in the incoming water should be analyzed and an appropriate quantity of planktons of the above-mentioned species should be added as required. Such addition should be done only after analyzing the pre-existing population of organisms 10µm or larger but smaller than 50µm in size.

(3) As to heterotrophic bacteria, it is known that they exist in the local seawater around the test site normally at the concentration of  $10^4$ cfu/mL or more, Therefore, no adjustment (addition of bacteria) should be performed.



Table 2 Salinity ranges and water quality requirements for incoming water in the land-based testing

	Salinity ranges		
	> 32PSU	3 - 32 PSU	< 3PSU
Dissolved organic carbon (DOC)	> 1mg/l	> 5mg/l	> 5mg/l
Particulate organic carbon (POC)	> 1mg/l	> 5mg/l	> 5mg/l
Total suspended solids (TSS)	> 1mg/l	> 50mg/l	> 50mg/l

## 7. Test Cycle and Procedure

The following defines one complete test cycle:

- (1) Water is taken into a tank using the ballast water pump. (This is done separately for the treated water and the control water.)
- (2) Chemical washing and the detoxifying of the chemical washing solution [This cleaning of the BWMS is done in parallel to Step (3) below.]
- (3) The ballast water is kept in the tanks (dummy ballast tanks in the barge on which the test set is built).
- (4) Water is discharged using the ballast water pump. (This is done separately for the treated water and the control water.)
- (5) The tanks are cleaned.

See Attachments 1 through 6 for the illustration of flows in each step.

## 8. Sampling and Analysis Methods

### 8.1 Sampling method

The collection of samples for various analyses should be done using an isokinetic sampling nozzle. To enable the determination of the sampled water flow rate, each sampling nozzle should have a flowmeter and a flow regulating valve. (See Photo 1. A sampling device like this should be attached to the treated water line, the control water line and the discharged water line.) All transportations of the incoming water should be done using the ballast water pump (Photo 2). Since the counting of planktons require the sampling of one cubic meter ( $1\text{m}^3$ ) of water,  $1\text{m}^3$  sampling tanks (Photo 3) should be used. A plankton net should be used to concentrate the sample (Photo 4).

### 8.2 Sampling regime and sample size



(1) Viable organisms of 50µm or larger in size (L-size group organisms)

In the analysis of the treated water, sample one cubic meter (1m) of water, measuring it using a sampling tank, and concentrate it before analysis.

In the analysis of the incoming water or the control water, sample 20L of water and concentrate it before analysis.

(2) Viable organisms of 10µm or larger but smaller than 50µm in size (S-size group organisms)

In the analysis of the incoming water or the control water, sample 1L of water and concentrate it before analysis.

In the analysis of the treated water, sample 10L of water and concentrate it before analysis.

(3) Bacteria

Sample 500mL of water using a container that has been sterilized.

(4) Water quality [pH, salinity, water temperature, dissolved oxygen particulate organic carbon (POC) total suspended solids (TSS) and turbidity (NTU: Non-mineral Turbidity Unit)]

The pH, salinity, water temperature, dissolved oxygen and NTU should be measured locally using an instrument, using a sample of 5L or larger. The measurement of POC, DOC and TSS should be done at an analyzing laboratory. The sample size should be 250mL for POC and DOC; 1L for TSS.

### 8.3 Analysis methods

The analysis methods should be as described in “2, Analytical Methods” in Document D-01-01 “Quality Assurance Project Plan.”

### 8.4 Miscellaneous (Instructions about Record-keeping during the Test)

The following should be documented during the test:

- (1) Flow rate of the treated water taken into the treated water tank and of the control water (untreated water) taken into the control water tank
- (2) Flow rate of water discharged from the treated water tank and the control water (untreated water) tank
- (3) Volume of treated ballast water stored in the treated water tank and of the control water (untreated ballast water) stored in the control water tank
- (4) Hydrogen peroxide concentration, flow rate, time and pressure as parameters concerning the chemical washing operation
- (5) Hydrogen peroxide concentration, flow rate, time and pressure as parameters concerning the detoxifying operation
- (6) Capacities of the treated water tank and the control water (untreated water) tank
- (7) Flow of water into sampling devices during sampling



(8) Other relevant information

9. Test Implementation Schedule

Table 3 shows the schedule of tests addressing different test cases:

Table 3. Test implementation schedule

Test case	Date of ballast water uptake (and treatment) (Y/M/D)	Date of ballast water discharge (Y/M/D)
Seawater 1	2010/5/26	2010/5/31
Seawater 2	2010/6/9	2010/6/14
Seawater 3	2010/6/23	2010/6/28
Seawater 4	2010/9/10	2010/9/15
Seawater 5	2010/9/29	2010/10/4
Brackish water 1	2010/7/7	2010/7/14
Brackish water 2	2010/7/21	2010/7/28
Brackish water 3	2010/8/4	2010/8/9
Brackish water 4	2010/8/18	2010/8/23
Brackish water 5	2010/9/1	2010/9/6



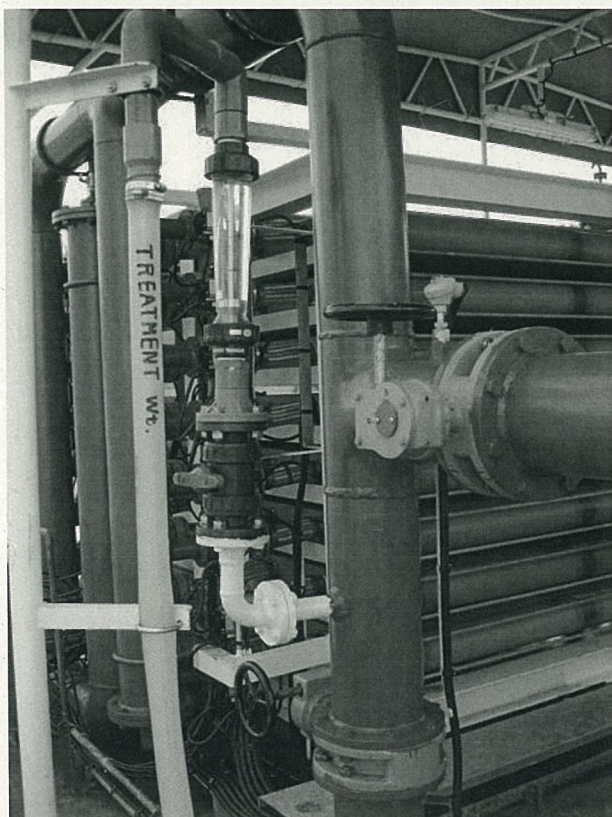


Photo 1 Sampling point (for treated water)

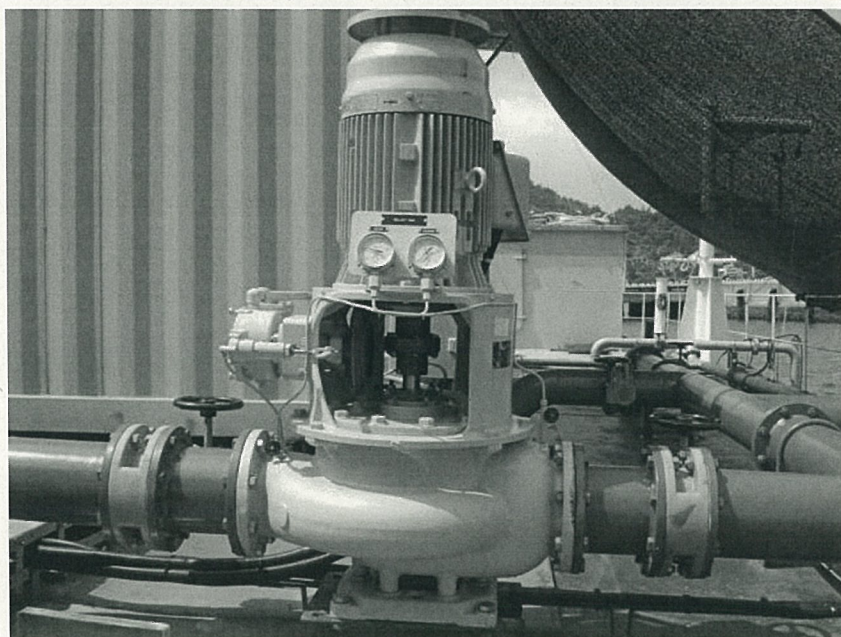


Photo 2 Ballast water pump



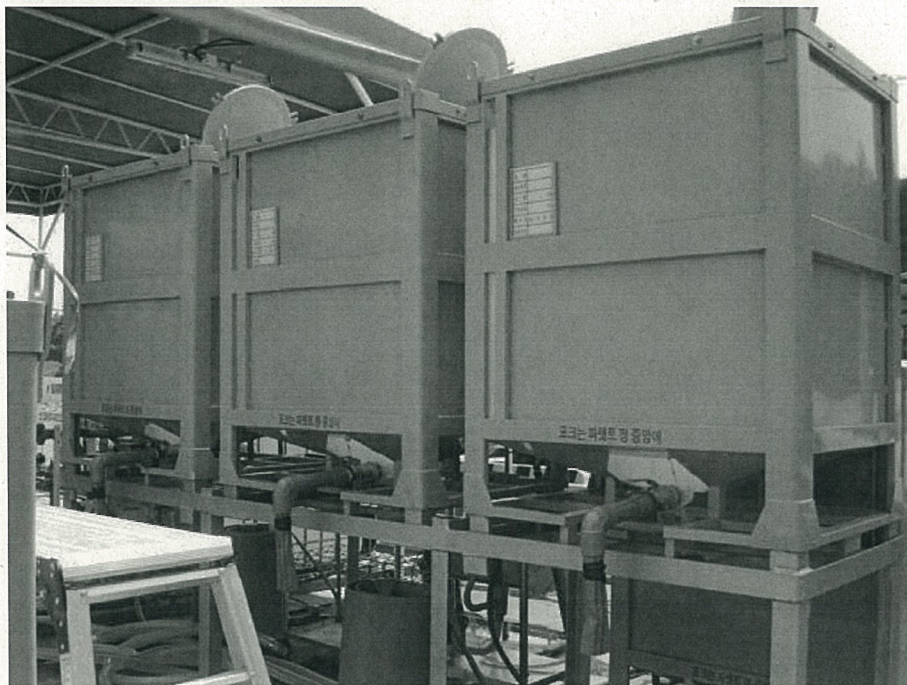


Photo 3 Sampling tanks (1m<sup>3</sup> x 3)

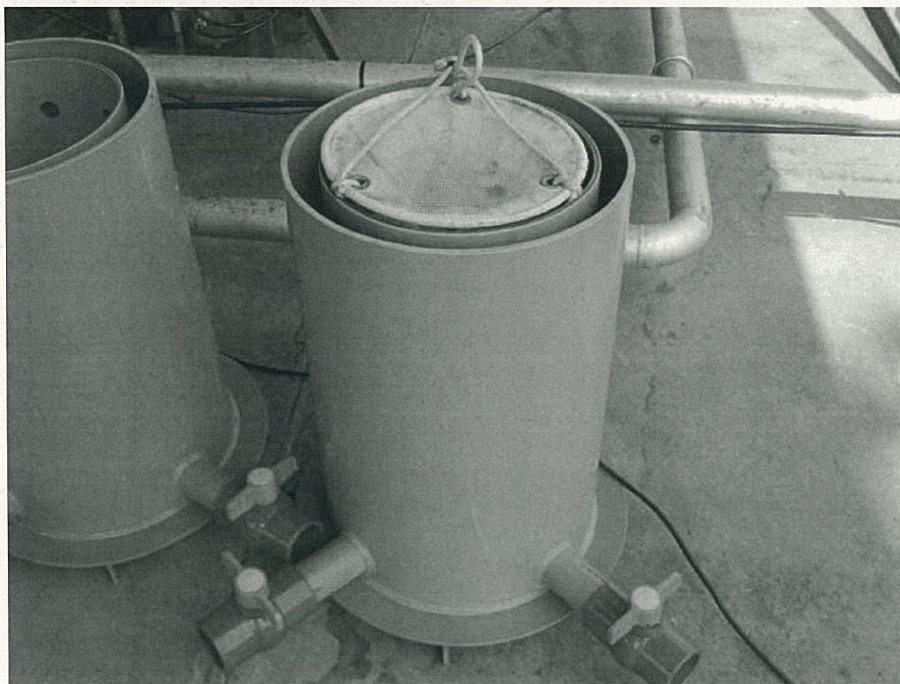


Photo 4 Plankton concentrator

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